

# **AIR POLLUTION**

any undesirable change in the quality  
of air that harmfully affects our  
wellbeing.

# SYLLABUS

- Atmosphere stratifications
- In the Troposphere: Global environmental issues and remedial measures:
  - Global warming
  - Acid rain
  - PC smog
  - Ozone depletion
- Types and sources of air pollutants;
- Emission and air quality standards, PUC
- Air pollution control
- Case studies.

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- **General source of pollutants**
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  - ❖ **Occupational health hazards – Berylliosis, Asbestosis, Silicosis, Anthracosis, Black lung disease**
  - ❖ **Global issues:**
    - **Global warming**
    - **Photochemical smog**
    - **Ozone layer depletion**
    - **Acid Rain (water pollution)**
- **Control of air pollution**
- **National Ambient Air Quality Standards (NAAQS)**
- **Emission norms and emission standards**

# DEFINITION

Pollution can be defined as any undesirable change in the physical, chemical and biological characteristic of air, water or land that may or will harmfully affect human life or that of various species, our industrial processes, living conditions and cultural assets.

# CLASSIFICATION OF POLLUTANTS

Generally a pollutant is classified as biodegradable and non-biodegradable.

- Biodegradable pollutants are those which degrade easily such as sewage, paper products, vegetables, juice, seeds and leaves.
- Non-biodegradable pollutants are those which do not degrade or degrade very slowly, such as plastics, metal, rubber and glass.

# GENERAL SOURCE OF POLLUTANTS

- I. Mobile transport
- II. Stationary / immobile combustion
- III. Factories and industry processes
- IV. Disposal of solid wastes

# STATUS OF POLLUTION IN INDIA

A **Comprehensive Environmental Pollution Index (CEPI)** is used to typify the quality of the environment at a particular locality ensuing the source of pollution, their path or conduit and the receiver.

CPCB or SPCB or Pollution Control Committees in alliance with IIT Delhi, had applied Central Environmental Pollution index to eighty eight specific industrial clusters or areas in 2009.

Out of **eighty eight** spots:

- 43 were “critically polluted” (with score more than 70 out of 100).
- 32 were “severely polluted” with scores varying between 60 and 70.

In the **interim assessment report** that was carried out in 2012:-

- Vapi rank first in pollution with a CEPI score of 90.75 out of 100,
- Angul Talcher ranked second with 89.74, while
- Vatva and Ankleshwar rank sixth and seventh respectively.

# CLASSIFICATION OF AIR POLLUTANTS

## A. BASED ON ORIGIN:

- Primary Pollutants: those pollutants which are emitted directly into the air and are found in the same chemical form in which they are released. E.g., Particulate matter,  $\text{SO}_2$ ,  $\text{NO}_x$ , CO, HC.
- Secondary Pollutants: these are generated in the environment by interactions between two or more primary pollutants. E.g.,  $\text{O}_3$ , PAN,  $\text{H}_2\text{SO}_4$ ,  $\text{HNO}_3$ .



# SOURCES OF AIR POLLUTION

## i. Natural Sources:

Process	Pollutants Produced
Volcanoes	Sulphur dioxide, fly ash
Forest fire	CO, Fume, smoke
Biological decay	Methane(CH <sub>4</sub> ), ammonia (NH <sub>3</sub> )
Storm wind	Hydrogen sulphide (H <sub>2</sub> S)
Ocean release	Dust particles
Plants and micro organism	CO <sub>2</sub> , Salt spray Pollens, fungi spores

## ii. Anthropogenic or Man-made Sources:

### 1. Domestic

- Coal combustion generates smoke, soot, dust, CO, SO<sub>2</sub>, NO<sub>x</sub>.
- Burning of LPG releases fewer amounts of pollutants comparatively.

### 2. Automobiles

- It is contributing nearly 60 – 70 % of air pollution.
- India is the 5<sup>th</sup> leading car producer in the world in 2011.
- It is the leading producer of three-wheelers (8,78, 000 in 2011-12).
- The number of government registered vehicles on roads in India is 142 million vehicles in the year 2011-2012.  
(MoEF, Annual report, 2012-13)

### 3. Industries

- **Fertilizer Plants** - generates sulphur oxides, nitrogen oxides, hydrocarbons, PM and fluorine.
- **Thermal Plants** - fly ash, soot,  $\text{SO}_2$ , CO,  $\text{NO}_x$ .
- **Textile Industries** - cotton fibres and dust,  $\text{NO}_x$ , chlorine gas, naphtha vapours, smoke and  $\text{SO}_2$ .
- **Steel Plants and metallurgical operations** - carbon monoxide, carbon dioxide, sulphur dioxide, phenol, fluorine, cyanide, particulate matter, copper, lead, zinc etc.
- **Petroleum** - Fossil fuels include petroleum and coal; emissions are mainly sulphur dioxide. Additionally, carbon monoxide (CO), carbon dioxide ( $\text{CO}_2$ ), nitrogen oxides, hydrocarbons, particulate matter and traces of metals are produced.
- **Paper and Pulp** - PM,  $\text{SO}_2$ ,  $\text{H}_2\text{S}$ , Methyl mercaptan.
- **Food processing** - often releases dimethyl sulphide and various types of odour.

### 4. Agriculture

- mainly pesticides and herbicides - Chlorinated hydrocarbons, phosphates, nitrates etc.

# MAJOR AIR POLLUTANTS

- Aerosols and VOCs
- Other hydrocarbons
- Particulate matter (inorganic and organic)
- Oxides of carbon
- Sulphur dioxide
- Oxides of nitrogen

# AEROSOLS

- Aerosols are tiny particles of solid or liquid suspended in the air.
- Most of the aerosols concentrated in the Northern Hemisphere, due to industrial development, slash-and-burn cropland, and overgrazed grasslands.
- Examples: smoke, oceanic haze, smog.

# **VOLATILE ORGANIC COMPOUNDS (VOCs)**

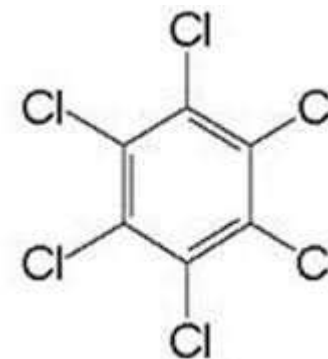
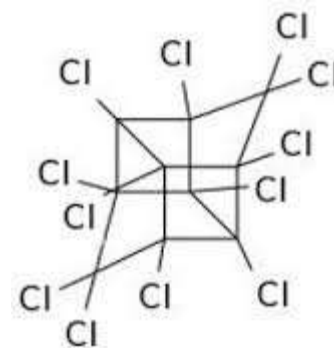
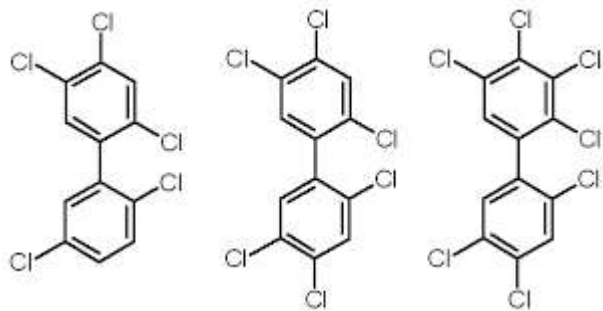
- Class of organic chemical compounds with substantial vapor pressure at room temperature.
- Include both natural and man-made chemical compounds.

# **VOLATILE ORGANIC COMPOUNDS (VOCs)**

- Commonly used in household products like paints and solvents; wood preservatives; aerosol sprays, cleansers and disinfectants, moth repellents and air fresheners, stored fuels and automotive products, dry-cleaned clothing.
- Examples - Acetone, Benzene, Ethylene glycol, Formaldehyde, Methylene chloride, Perchloroethylene, Toluene, Xylene, 1, 3-butadiene and an important class of compounds called terpenes, such as myrcene.

# PERSISTENT ORGANIC POLLUTANTS (POPS)

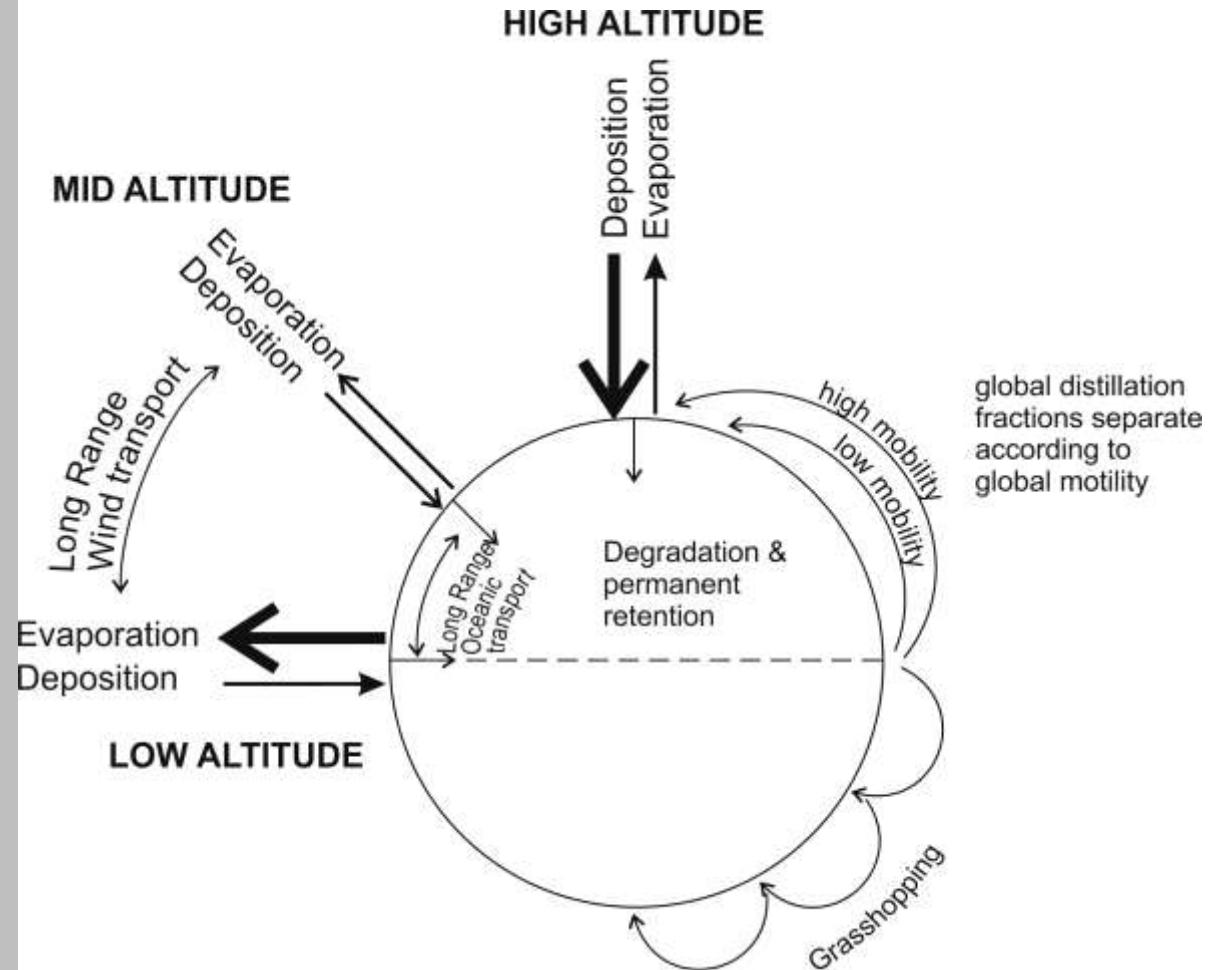
- Persistent organic pollutants (POPs) are toxic organic class of compounds that has become a global concern.





# Global distillation or Grasshopper movement of POPs

- Process goes on and on with highest concentrations occurring in the circumpolar nations.
- In view of this the Arctic Council was constituted by Denmark, Sweden, Iceland, Norway, Russia, Alaska, Greenland, Finland, etc. to monitor and assess the source and pathway of the POPs.



- POPs lasts for an **extended period** in the environment; accumulate and go into from **one trophic level to the next** through the food chain.
- In 1992, under UN/ECE (European Commission of Europe) the **Convention of Long Range Transboundary Air Pollution (LRTAP)** was constituted to identify the chemicals of potential concern.
- In **2001**, USA with 90 other nations and EU signed the treaty in **Stockholm**, Sweden. Under this treaty the nations decided trimming down or eliminating the production, utilization, and/or discharge of twelve main culprits, known as '**dirty dozen**'.

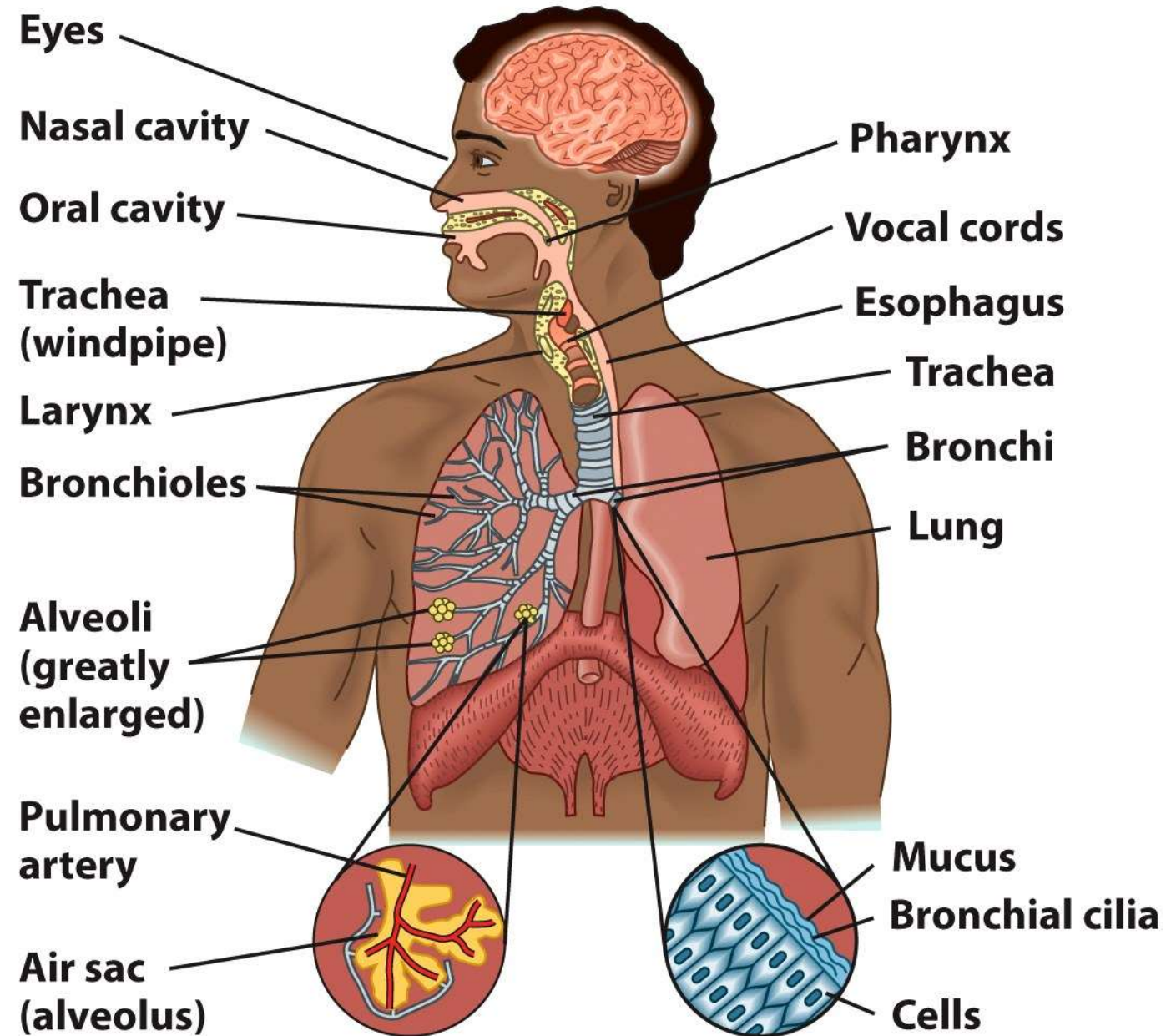
# The dirty dozen

1. **Aldrin** -Pesticide, closely related to dielrin; extensively used on corn and cotton and for termite control.
2. **Dieldrin** - Pesticide widely used on corn and cotton pests. It is also a metabolite of aldrin.
3. **Chlordane**- Pesticide on crops, lawns, and gardens and a fumigant for termite control.
4. **Heptachlor** - Insecticide for household and agricultural uses. It is also a component and a breakdown product of chlordane.
5. **DDT**- Pesticide; used for controlling malaria since 2<sup>nd</sup> world war; discovered by Paul Mueller.
6. **Endrin**- Used as insecticide, rodenticide, and also to control birds.

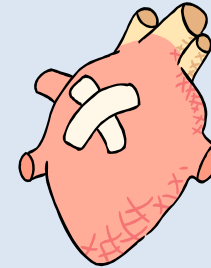
- 7. Hexachlorobenzene (HCB)**- used as pesticide and fungicide used on seeds, is also an industrial byproduct.
- 8. Mirex**- used as insecticide and as flame retardant.
- 9. Toxaphene** - Insecticide used on cotton pests.
- 10. PCBs or Polychlorinated biphenyls**, widely used in electrical equipment.
- 11. Polychlorinated Dioxins and**
- 12. Polychlorinated Furans** - Two notorious classes of “unintentional” pollutants, produced as byproducts of incineration and industrial processes.

# PARTICULATE MATTERS

- A generic term used for a subdivision of solid particles or liquid droplets suspended in a gas or liquid.
- They differ in origin, size, and their chemical composition, all of which are  $<10\text{ }\mu\text{m}$  in size.
- Particles with aerodynamic diameter less than equal to  $2.5\text{ }\mu\text{m}$  are known as PM<sub>2.5</sub>. The lesser the diameter, more will be the penetrating ability and greater will be the hazard. Evidence indicates that respirable particulate matter (RPM) or PM<sub>10</sub> is linked to health hazards.



- Upper RTI are symptomized by are stuffy nose, sinusitis, sore throat, hay fever, cough, and irritation of eyes.
- Symptoms of the lower respiratory tract infections are wheezing, phlegm(thick mucus), dyspnea (difficult breathing), asthma, pain in chest, emphysema, etc.
- RPM slow the ciliary beat and mucous flow inflammation of lung tissue.
- PM causes alterations in blood chemistry and can increase susceptibility to viral and bacterial pathogens.
- Particulates like arsenic, PAH, radioactive nuclei are carcinogens.



## CHLOROFLUORO CARBONS (CFCS)

- Organic compound comprising carbon, chlorine, and fluorine, produced as a capricious derivative of methane and ethane and commonly known as **'Freons'**.
- Extensively used as refrigerants, propellants and solvents.
- Presently, gases, such as helium, propane/isobutane mixtures are used as refrigerants.



# OCCUPATIONAL HEALTH HAZARDS

## 1. BERYLLIOSIS

- It is a kind of pneumoconiosis; a systemic granulomatous disease, mainly affecting the lungs.
- Affect employees working in beryllium alloy industry, ceramic objects, foundry, cathode ray tubes, gas blanket, projectile, and nuclear reactors.
- Two forms: **acute nonspecific pneumonitis** and **chronic granulomatous disease** with interstitial fibrosis, which may cause respiratory failure and ultimately **death**.

# What is air quality management?

**Air quality management (AQM) (refers to all the activities a regulatory authority undertakes to make sure that the air we breathe is safe, both outdoors and indoors.**

**The AQM process is the system of understanding the sources that contribute to pollution in the air and the health and environmental effects of the pollutants, and then taking steps to reduce or control the sources to reach or maintain agreed upon target pollution levels in the air .**

**These levels may vary from country to country, but the overall system for planning, assessing, characterizing, mitigating, and implementing control strategies is similar.**

**While AQM is generally handled at the national government level, regional and local governments, industry, and the [public](#) all have important roles to play in this system .**

**Each air quality management activity is related to the others .It is also important to recognize that the entire AQM process is dynamic -there is a continuous review and assessment of standards and strategies based on their effectiveness and new research on health and environmental effects.**

# Criteria Pollutants

U.S .EPA uses six "[criteria pollutants](#)" as indicators of air quality, and has established for each of them a National Ambient Air Quality Standards:

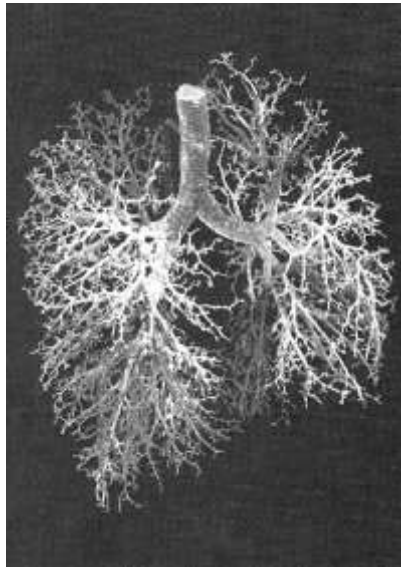
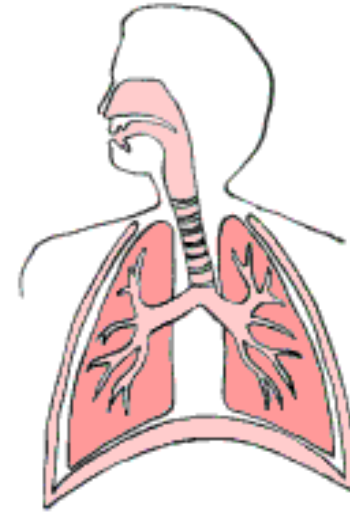
- **Particulate matter**
- **Ground-level ozone**
- **Nitrogen dioxide**
- **Carbon monoxide**
- **Sulfur dioxide**
- **Lead**

When an area does not meet the air quality standard for one of the criteria pollutants, it may be defined as non-attainment (especially for ozone, carbon monoxide, and some particulate matter) .

Non-attainment classifications may be used to specify what air pollution reduction measures an area must adopt, and when the area must reach attainment .

# Particulate Matter

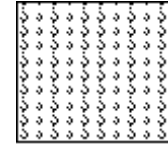
- Larger particles ( $> PM_{10}$ ) deposit in the upper respiratory tract
- Smaller, inhalable particles ( $\leq PM_{10}$ ) penetrate into the lungs
- $PM_{10-2.5}$  are thoracic coarse PM
- $PM_{2.5}$  go deeper than  $PM_{10-2.5}$



- Smallest particles (ultrafines,  $PM_{0.1}$ ) may enter bloodstream
- Deposited particles may accumulate, react, be cleared or absorbed

# Specific Air Pollution Treatment Technology

- Traditional
  - **Move factory to remote location**
  - **Build taller smokestack so wind blows pollution elsewhere**
- New
  - **Biofiltration : vapors pumped through soil where microbes degrade**
  - **High-energy destruction: high-voltage electricity**
  - **Membrane separation: diffusion of organic vapors through membrane**
  - **Oxidation: High temperature combustor**



## **VEHICULAR POLLUTION CONTROL**

- Improved fuel quality – Bharat Stage IV in major cities, Bharat Stage – III in rest of the country**
- Alternate cleaner fuel (CNG/LPG)**
- Progressive emission norms for vehicles**
- Improvement in public transport system (Metro)**
- Phasing out of old commercial vehicles**
- Better traffic management – Restriction on goods vehicles during day time, Installation of time clocks at important crossings, Construction of more flyovers and subways and closing of T-Junctions, Regular information about traffic flow through radio**

# Control Strategies

A control strategy is a set of discrete and specific measures identified and implemented to achieve reductions in air pollution. These measures may vary by source type, such as stationary or mobile, as well as by the pollutant that is being targeted. The purpose of these measures is to achieve the air quality standard or goal. Costs and benefits are assessed in the development of the control strategy.